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Niiyama

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(54) **BLOOD MEASURING APPARATUS**

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G01N 15/12 (2006.01)
G01N 15/06 (2006.01)
G01N 15/10 (2006.01)

(52) **U.S. Cl.**

CPC ***G01N 15/12*** (2013.01); ***G01N 15/0656*** (2013.01); ***G01N 15/1056*** (2013.01); ***G01N 15/1218*** (2013.01); *G01N 2015/1062* (2013.01)

(58) **Field of Classification Search**

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USPC 324/71.4; 210/645; 239/405; 73/865.5
See application file for complete search history.

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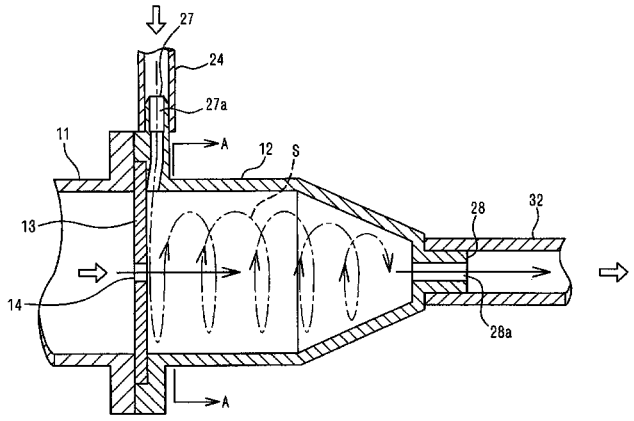
(57) **ABSTRACT**

A blood measuring apparatus includes: a first chamber which includes a first wall provided with an aperture and in which diluted blood is contained; a second chamber which includes the first wall, a second wall opposed to the first wall and a peripheral wall and in which diluting solution is contained, the first and second chambers communicating with each other through the aperture; first and second electrodes which are disposed in the first and second chambers, respectively; a measuring unit which performs a blood measurement by causing a current to flow between the first and second electrodes; a diluting solution supplying unit which supplies diluting solution along a part of the peripheral wall which is adjacent to a peripheral edge of the first wall; and a sucking unit which sucks the diluting solution from the second wall.

6 Claims, 5 Drawing Sheets



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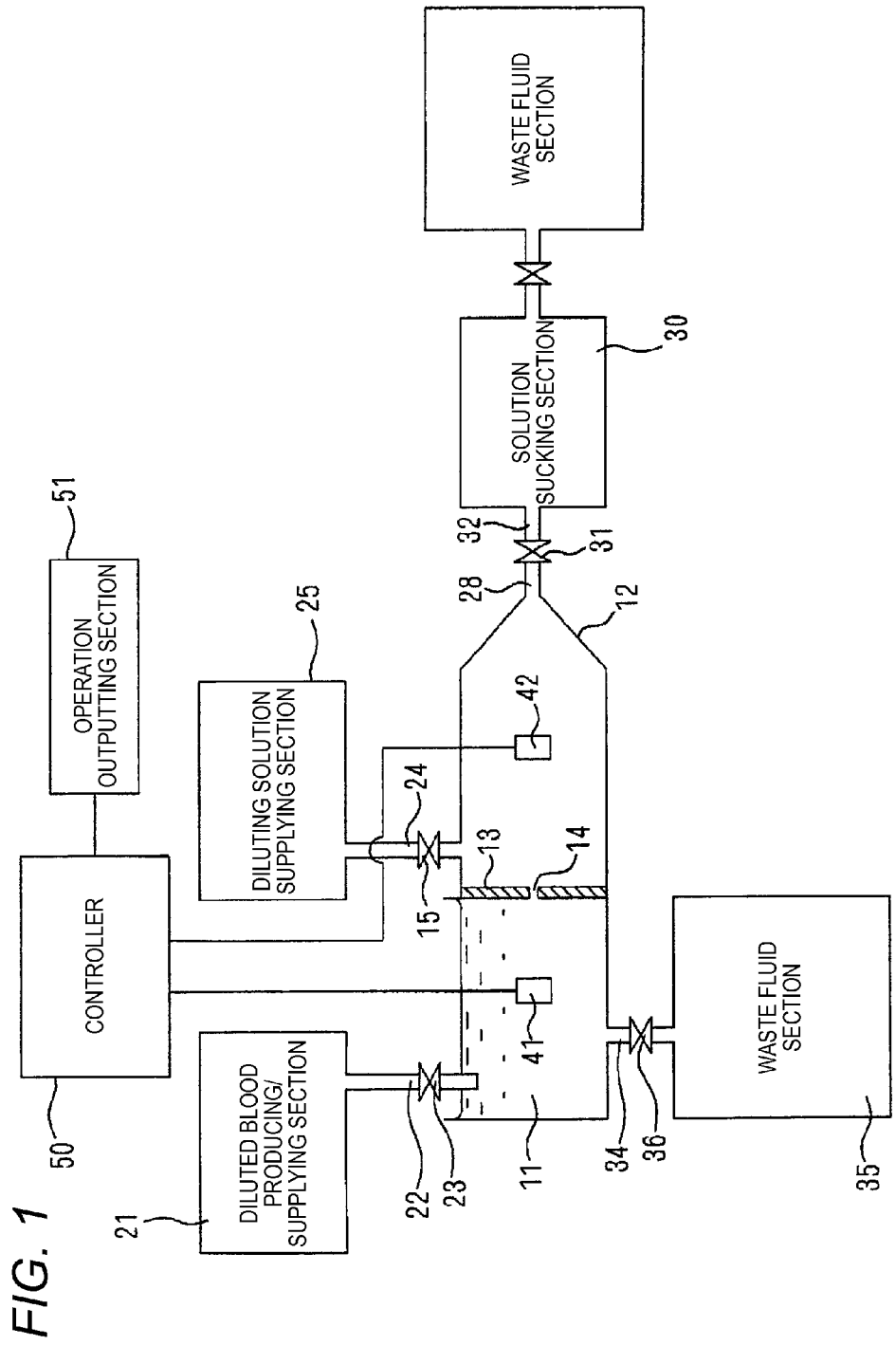

WASTE FLUID SECTION
SOLUTION SUCKING SECTION
30
32
31
28
12
42
OPERATION OUTPUTTING SECTION
51
DILUTING SOLUTION SUPPLYING SECTION
25
24
13
14
15
CONTROLLER
50
41
DILUTED BLOOD PRODUCING/ SUPPLYING SECTION
21
22
23
11
34
36
WASTE FLUID SECTION
35

FIG. 1

FIG. 2

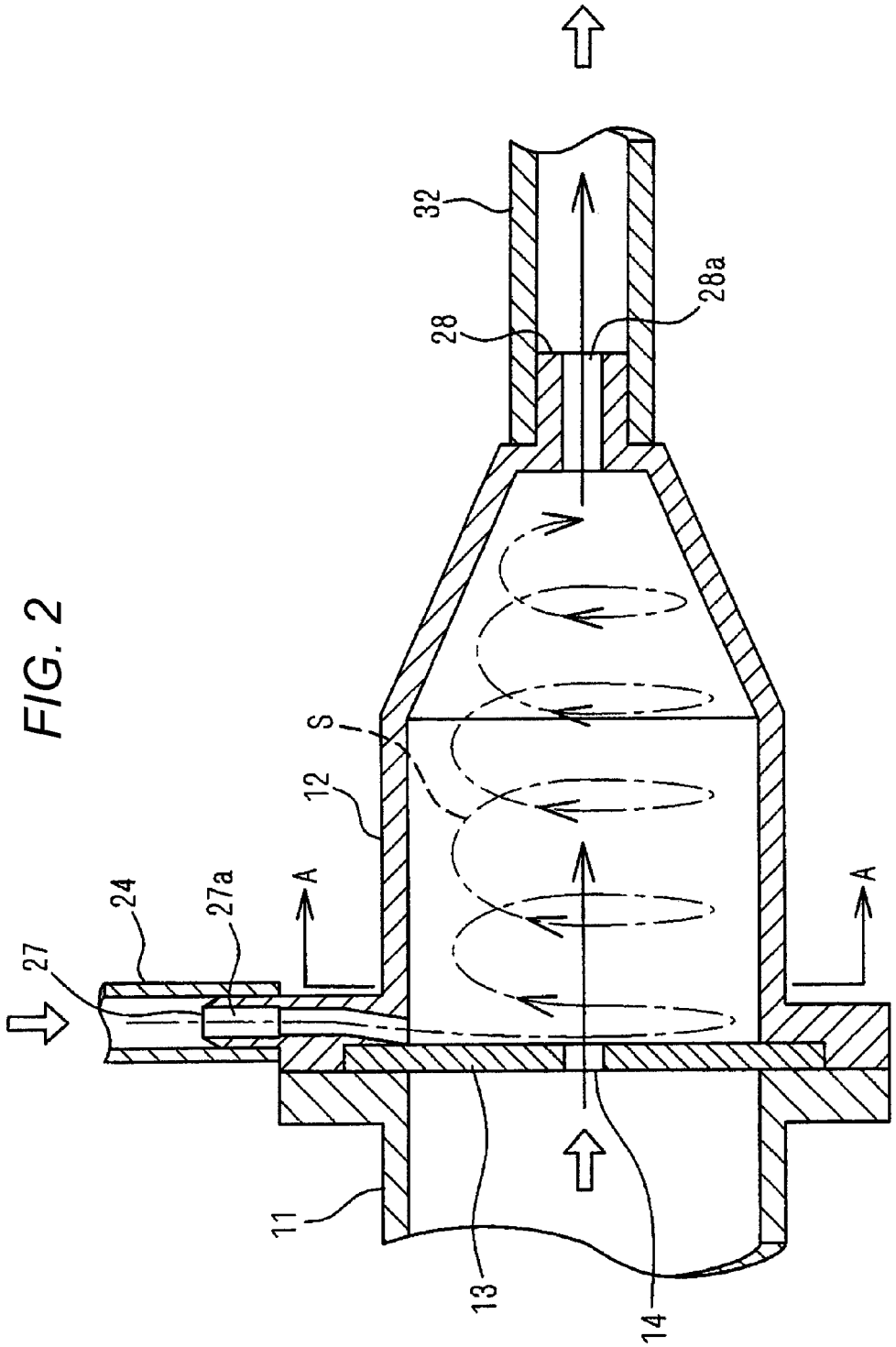


FIG. 3

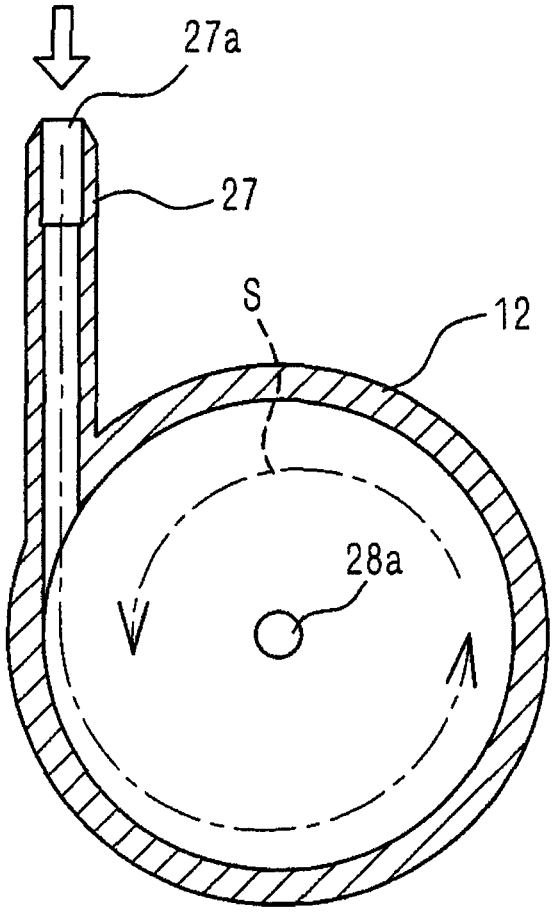


FIG. 4

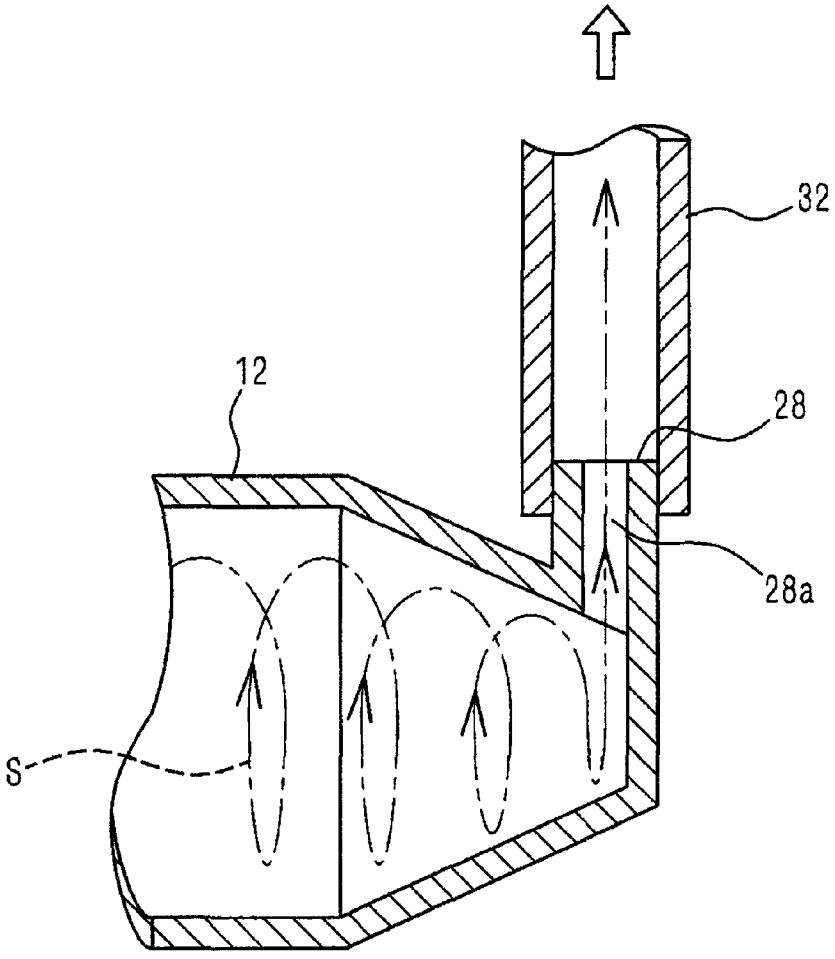
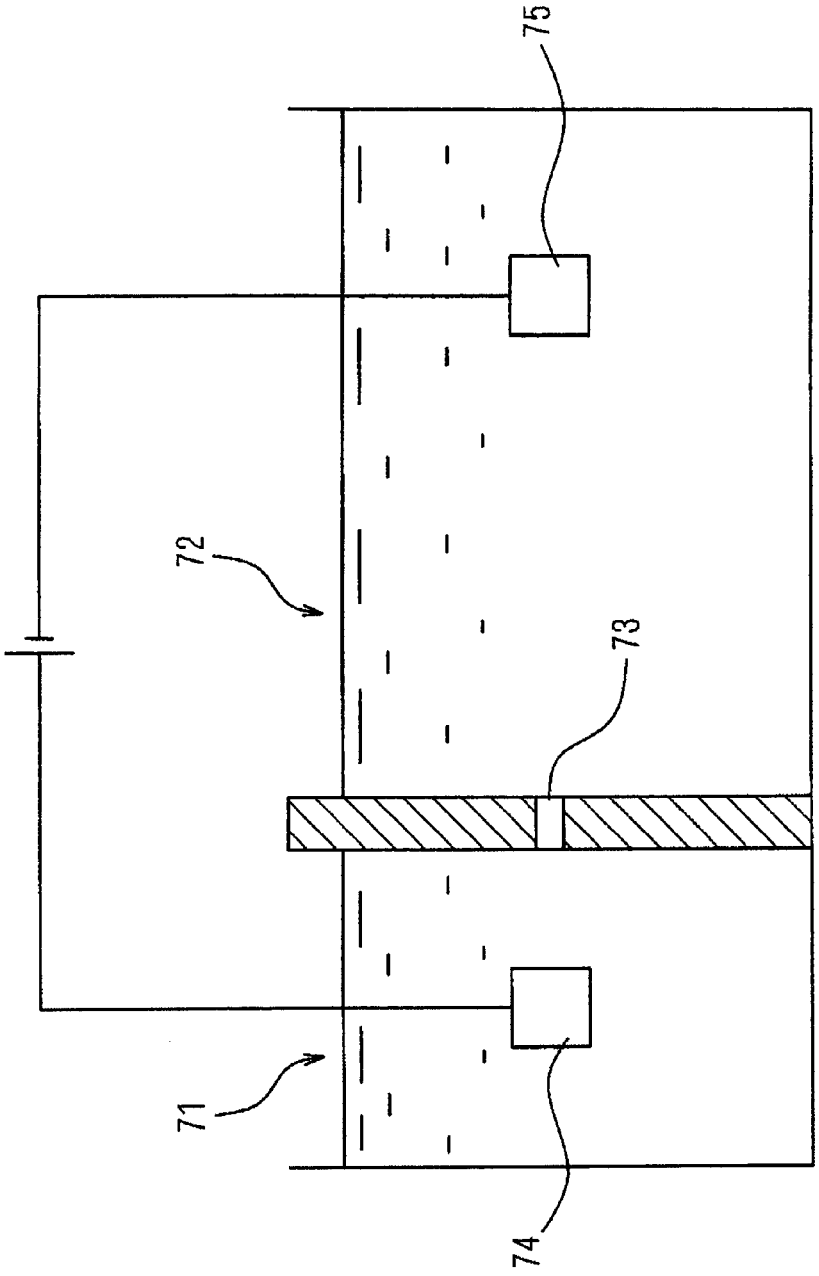


FIG. 5



BLOOD MEASURING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a blood measuring apparatus which performs a blood measurement by using the electrical resistance method.

A related-art blood measuring apparatus is configured as shown in FIG. **5**. An aperture **73** configured by a minute hole is disposed between a first chamber **71** and a second chamber **72**. An electrode **74** is disposed in the first chamber **71**, and an electrode **75** is disposed in the second chamber **72**. Diluted blood is contained in the first chamber **71**, and a diluting solution is contained in the second chamber **72**.

In the related-art blood measuring apparatus in the above-described state, a minute current is caused to flow between the electrodes **74** and **75** through the aperture **73**, a resistance change due to blood cells existing between the electrodes **74** and **75** is captured as a change in potential, and a blood measurement (blood cell count) is performed based on the potential change.

The diluted blood which flows from the first chamber **71** into the second chamber **72** through the aperture **73** is carried at an approximately constant distance after flowing into the second chamber **72**, by a flow current which is directed toward the aperture **73**, and then recirculates to the sensing region due to the electrodes **74** and **75**. Therefore, recirculating blood cells exist in the sensing region, and hence it is impossible to capture a resistance change due to only blood cells passing through the aperture **73**, so that there is a possibility that the counting operation is erroneously performed.

Moreover, a dead water region where liquid does not flow is produced in the vicinity of the aperture **73**. Therefore, air bubbles adhere to a wall portion constituting the sensing region where the aperture **73** is included, and the adhering state of bubbles is varied by a pressure change or a change in liquid flowing state, thereby producing a problem in that such a variation may cause noises during the measurement.

As a related-art technique for, in the blood cell counting measurement, preventing a situation where an error is caused by re-detection due to vortex flow which is formed immediately after the passage through a minute hole, from occurring, there is the back sheath technique (see the right column of page 1 of JP-A-61-159134). When the technique is employed, however, the structure of an apparatus is complicated.

SUMMARY

It is therefore an object of the invention to provide a blood measuring apparatus in which blood cells that have passed through an aperture do not recirculate a sensing region, whereby an erroneous measurement can be prevented from occurring. It is another object of the invention to provide a blood measuring apparatus in which air bubbles hardly adhere to a wall portion constituting the sensing region where the aperture is included, and therefore noises are prevented from being produced during the measurement.

In order to achieve the object, according to the invention, there is provided a blood measuring apparatus comprising: a first chamber which includes a first wall provided with an aperture and in which diluted blood is contained; a second chamber which includes the first wall, a second wall opposed to the first wall and a peripheral wall and in which diluting solution is contained, the first and second chambers communicating with each other through the aperture; first and second electrodes which are disposed in the first and second chambers, respectively; a measuring unit which performs a blood measurement by causing a current to flow between the first and second electrodes; a diluting solution supplying unit which supplies diluting solution along a part of the peripheral wall which is adjacent to a peripheral edge of the first wall; and a sucking unit which sucks the diluting solution from the second wall.

The second chamber may have a cylindrical shape, the sucking unit may suck the diluting solution from a suction portion of the second wall, and a diameter of the suction portion of the second wall may be smaller than a diameter of the first wall.

A diameter of the peripheral wall may be gradually reduced as advancing from a predetermined portion toward the suction portion.

The diluting solution supplying unit may supply the diluting solution to generate a swirling flow.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing an embodiment of the blood measuring apparatus of the invention.

FIG. **2** is a longitudinal sectional view of a part of the embodiment of the blood measuring apparatus of the invention.

FIG. **3** is a sectional view taken along A-A in FIG. **2**.

FIG. **4** is a longitudinal sectional view showing a modification of apart of the embodiment of the blood measuring apparatus of the invention.

FIG. **5** is a schematic diagram illustrating a related-art blood measuring apparatus.

DETAILED DESCRIPTION OF EMBODIMENTS

Hereinafter, an embodiment of the blood measuring apparatus of the invention will be described with reference to the accompanying drawings. In the figures, the identical components are denoted by the same reference numerals, and duplicate description will be omitted. FIG. **1** shows a block diagram of the embodiment of the blood measuring apparatus. The blood measuring apparatus includes a first chamber **11** and a second chamber **12**. The first chamber **11** and the second chamber have a cylindrical (true cylindrical or elliptical cylindrical) shape in which the axis coincides with the lateral direction in the figure. The second chamber **12** is formed into a tapered shape in which the diameter is gradually reduced as advancing from a lateral approximately middle portion toward a right end portion.

A boundary wall **13** is vertically disposed between the first chamber **11** and the second chamber **12**. An aperture **14** is formed in a middle portion of the boundary wall **13**, and the first chamber **11** and the second chamber **12** communicate with each other through the aperture **14**.

The first chamber **11** is connected to a diluted blood producing/supplying section **21**. The diluted blood producing/supplying section **21** takes in sample blood by suction, dilutes the blood with a diluting solution (physiological saline or the like) to produce diluted blood, and supplies the diluted blood to the first chamber **11** through a pipe **22**. A valve **23** is disposed in the pipe **22**.

The second chamber **12** is connected to a diluting solution supplying section **25** through a pipe **24** in which a valve **15** is disposed. The diluting solution supplying section **25** stores the diluting solution. As shown in FIGS. **2** and **3**, the pipe **24** is coupled with a fitting portion **27** which is disposed in the side wall of the second chamber **12**. A flow path **27***a* in the

fitting portion **27** extends toward the inner wall on the side of the second chamber **12** adjacent to the peripheral edge of the boundary wall **13**.

The diluting solution supplying section **25** supplies the diluting solution by applying a predetermined pressure thereon. The supplied diluting solution flows in along the inner wall on the side of the second chamber **12** adjacent to the peripheral edge of the boundary wall **13** through the flow path **27***a*, and causes a swirling flow S to be produced in a situation where the second chamber **12** is filled with the diluting solution. In this way, the diluting solution supplying section **25** and the flow path **27***a* in the fitting portion **27** function as a diluting solution supplying unit which supplies the diluting solution along the inner wall on the side of the second chamber **12** adjacent to the peripheral edge of the boundary wall **13**, thereby generating a swirling flow.

A fitting portion **28** which is straightly projected to the outside is disposed in an end portion of the second chamber **12** which is opposed to the boundary wall **13**. An outlet **28***a* is formed in the fitting portion. The fitting portion **28** is connected to a solution sucking section **30** which constitutes a sucking unit, through a pipe **32** in which a valve **31** is disposed.

The solution sucking section **30** is configured by a suction pump and the like to suck the solution in the second chamber **12**. Therefore, blood cells in the diluted blood which flows out from the aperture **14** to the side of the second chamber **12** are sucked into the solution sucking section **30** with maintaining a state where the blood cells are collected in the swirl center by the swirling flow that is produced as described above, and without being dispersed about the periphery and causing recirculation. The sucked solution is stored in a waste fluid section which is connected to the solution sucking section **30**.

FIG. **4** shows a modification of the fitting portion **28**. In an end portion of the second chamber **12** which is opposed to the boundary wall **13**, the fitting portion **28** is disposed to be upward projected in perpendicular to the wall of the end portion. The projection direction of the fitting portion **28** is not particularly limited.

A waste fluid section **35** is connected to the first chamber **11** through a pipe **34** in which a valve **36** is disposed. The waste fluid section **35** is configured by a tank which takes in the diluted blood in the first chamber **11**, and which stores the diluted blood.

A first electrode **41** is disposed in the first chamber **11**, and a second electrode **42** is disposed in the second chamber **12**. The first electrode **41** and the second electrode **42** are opposed to each other across the aperture **14**.

The first electrode **41** and the second electrode **42** are connected to a controller **50**. The controller **50** is connected to an operation outputting section **51** having an outputting portion which displays or prints characters and the like, and an operating portion in which keys are disposed. The controller **50** controls the openings and closings of all the above-described valves, and functions as a measuring unit which sets a state where the diluted blood is contained in the first chamber **11**, and the diluting solution is contained in the second chamber **12**, and which causes a minute current to flow between the first and second electrodes **41** and **42** to perform a blood measurement.

The controller **50** captures a resistance change due to blood cells which are in the diluted blood, which flow from the first chamber **11** to the second chamber **12** through the aperture **14** and which exist between the first and second electrodes **41** and **42**, as a change in potential, and performs a blood cell counting based on the change in potential. A result of the measurement is output from the operation outputting section **51**.

During the measurement, the controller **50** opens the valve to supply the diluted blood from the diluted blood producing/supplying section **21**, thereby controlling the diluted blood so as to flow from the first chamber **11** to the second chamber **12** through the aperture **14**, and also opens the valve **15** to eject the diluting solution from the diluting solution supplying section **25** toward the inner wall on the side of the second chamber **12** adjacent to the peripheral edge of the boundary wall **13**, through the flow path **27***a* in the fitting portion **27**, thereby generating the swirling flow.

The swirling flow functions so as to collect the diluted blood which has flown to the side of the second chamber **12** through the aperture **14**, toward the swirl center. At this time, the controller **50** opens the valve **31**. Therefore, the solution sucking section **30** sucks the solution in the second chamber **12**, and hence the diluted blood which is collected to the swirl center by the swirling flow is sucked into the solution sucking section **30** through the fitting portion **28** with maintaining a state where the diluted blood is collected in the swirl center. Consequently, the diluted blood which has flown out toward the second chamber **12** through the aperture **14** is formed into one stream which is partly slightly curved, and then directed toward the solution sucking section **30**.

The process by the blood measuring apparatus of the embodiment is performed as described above. Therefore, blood cells can be prevented from recirculating to the sensing region, and an adequate measurement can be performed. Because of the swirling flow, air bubbles hardly adhere to the sensing region of the boundary wall **13**, so that noises can be prevented from being produced, and a correct measurement can be performed.

According to an aspect of the invention, since the diluting solution is supplied along the inner wall on the side of the second chamber adjacent to the peripheral edge of the boundary wall, thereby causing a swirling flow, blood cells are surrounded by the swirling flow and are not dispersed. Since the diluting solution is sucked from the wall portion of the second chamber which is opposed to the aperture, the diluting solution is sucked in the sucking direction while the diluted blood is collected toward the swirl center by the swirling flow, whereby blood cells in the diluted blood are prevented from recirculating to the sensing region, so that a clean diluting solution always flows in the vicinity of the aperture. Therefore, it is possible to perform a correct measurement. Because of the swirling flow, moreover, air bubbles hardly adhere to the sensing region of the boundary wall. Therefore, noises can be prevented from being produced, and a correct measurement can be performed.

According to an aspect of the invention, since the second chamber has a cylindrical shape, the supplied diluting solution smoothly circulates along the circumferential wall of the cylinder, and the swirling flow can be adequately generated. Furthermore, the suction portion for the diluting solution has a diameter which is smaller than that of the boundary wall portion. Therefore, the diluted blood which is collected into the swirl center by the swirling flow is sucked while being accelerated.

According to an aspect of the invention, since the diameter of the second chamber is gradually reduced as advancing from the predetermined portion toward the suction portion for the diluting solution. Therefore, the diluted blood which is collected into the swirl center by the swirling flow is sucked while being accelerated, and a correct measurement can be performed.

What is claimed is:

1. A blood measuring apparatus comprising:

a first chamber which includes a first wall provided with an aperture and in which diluted blood is contained;

a second chamber which includes the first wall, a second wall opposed to the first wall and a peripheral wall and in which diluting solution is contained, the first and second chambers communicating with each other through the aperture;

first and second electrodes which are disposed in the first and second chambers, respectively;

a measuring unit which performs a blood measurement by causing a current to flow between the first and second electrodes;

a diluting solution supplying unit which supplies diluting solution along a part of the peripheral wall which is adjacent to a peripheral edge of the first wall; and

a sucking unit which sucks the diluting solution from the second wall,

wherein

the diluting solution supplying unit supplies the diluting solution to generate a swirling flow,

the swirling flow swirls so as to surround the diluted blood flowing into the second chamber, and

the swirling flow swirls about an axis extending from the first wall to the second wall.

2. The blood measuring apparatus according to claim **1**, wherein the second chamber has a cylindrical shape, the sucking unit sucks the diluting solution from a suction portion of the second wall, and a diameter of the suction portion of the second wall is smaller than a diameter of the first wall.

3. The blood measuring apparatus according to claim **2**, wherein a diameter of the peripheral wall is gradually reduced as advancing from a predetermined portion toward the suction portion.

4. The blood measuring apparatus according to claim **1**, wherein the swirling flow has funneling motion.

5. The blood measuring apparatus according to claim **1**, wherein the swirling flow has vortex motion.

6. The blood measuring apparatus according to claim **1**, wherein the swirling flow has a whirlpool motion.

* * * * *